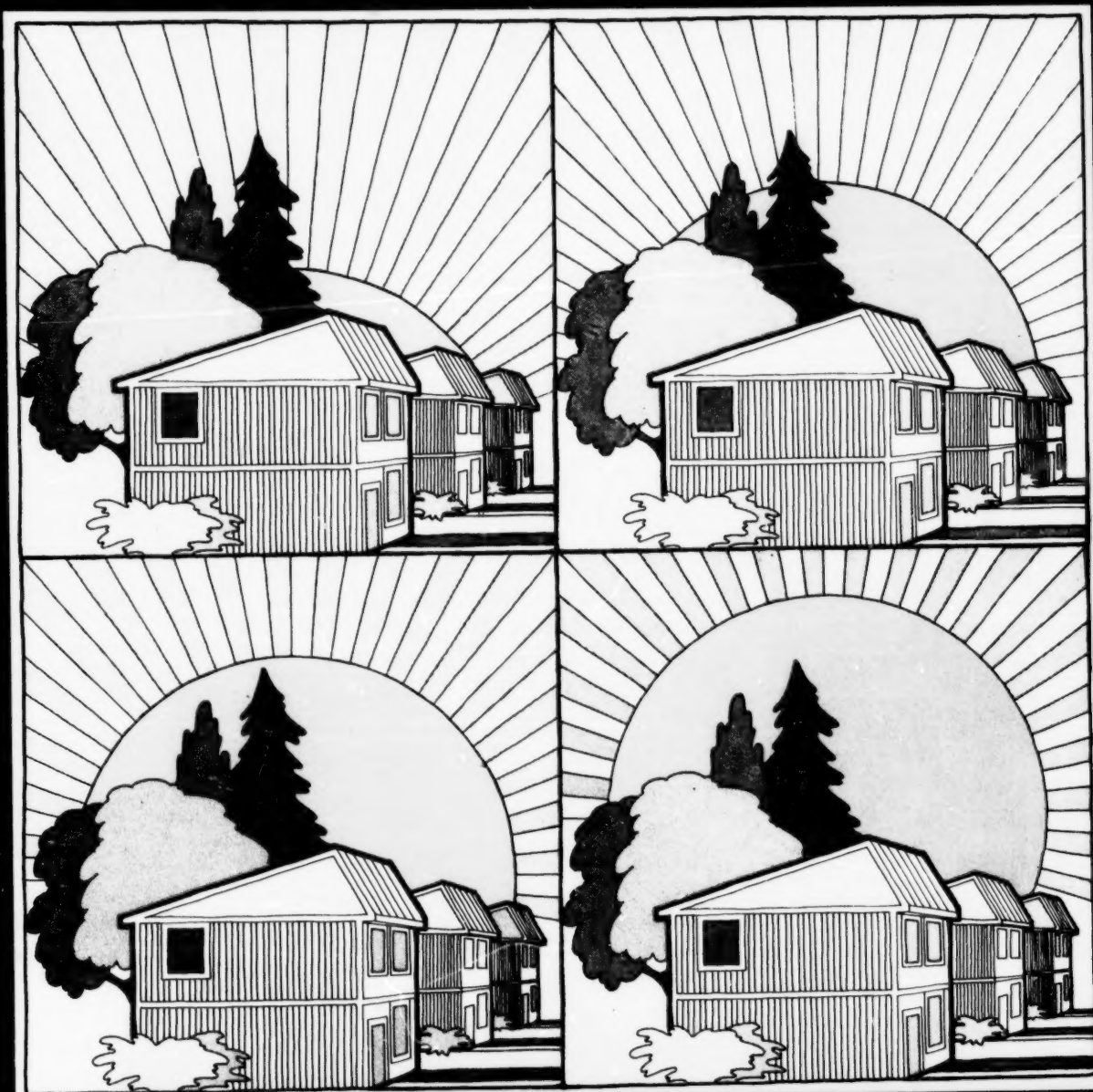


HANDBOOK FOR ENERGY EFFICIENT RESIDENTIAL SUBDIVISION PLANNING



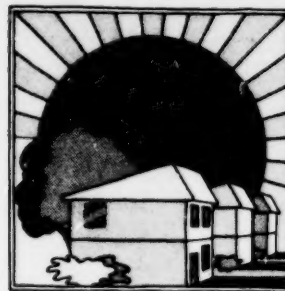
Overview



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HANDBOOK FOR ENERGY EFFICIENT RESIDENTIAL SUBDIVISION PLANNING



Ministry of Municipal Affairs
and Housing

Project Planning Branch

**Handbook for Energy Efficient
Residential
Subdivision Planning**

Part 1: Overview

**Ministry of Municipal Affairs
and Housing**

Project Planning Branch

February 1982

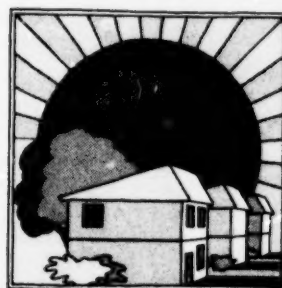
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PART 1

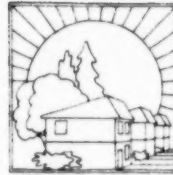
Overview



In January 1981, the Ministry of Housing issued a report on *Residential Site Design and Energy Conservation*. This basic study examined the possibilities of saving energy from conventional sources used for space heating. Houses were located within a subdivision with the main window areas facing south to utilize the radiation from the sun. This *Handbook for Energy Efficient Residential Subdivision Planning* is a consequence of the basic study.

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Introduction



Purpose of handbook

The *Handbook for Energy Efficient Residential Subdivision Planning* provides a comprehensive design guide for municipal planners and land developers. It shows how to design residential subdivisions that can reduce space heating needs with only marginal additional development costs by taking account of local solar and wind conditions.

The Handbook is to consist of approximately sixteen parts that are to be published separately. Each part deals with some aspect of subdivision design relevant to saving energy, such as quantifying the heating requirements of housing, protecting solar rights, landscaping, and calculating shadows.

This document is the first part of the Handbook. It serves as an overview of the implementation possibilities for saving energy by residential site design. It also reviews the topics that are covered in the parts to be subsequently issued.

Energy saving potential of subdivision design

Ontario's reliance on imported fossil fuels is well documented. It is established that the efficient use of energy for residential use helps substantially to achieve the Provincial goal of reducing the energy requirements from non-renewable sources.

Residential planning and design is one area where substantial savings can be made. Housing now consumes about 20 percent of Ontario's total energy requirements, and 70 percent of that residential need is for space heating.

In a recent report entitled *Saving Energy by Way of Site Design*, the Ministry of Housing has shown that a 20 percent saving in residential heating energy is possible in new subdivisions. It is achieved by orienting the main window areas to the south in order to utilize the sun's radiation, and by using landscaping and buildings to shelter the housing from the winter winds. These savings are possible without special equipment, unconventional house designs or higher development costs.

Considering the number of houses that are likely to be built, the amount of energy that could be conserved through more thoughtful subdivision design is considerable. Projections to the year 2001 estimate that in Ontario alone over one million new dwelling units will be added to the existing stock of three million. Over half of these are likely to be single detached, semi-detached and rowhouses built within a new subdivision.

The homeowner will be the main beneficiary of more energy-conscious residential design. Until recently little thought has been given to conservation because of the relatively low energy prices in this country. The cost for space heating has now increased to where it is a major household expense. With energy prices expected to rise even further, increasing efficiency will have a marked impact on home operating costs.

Role of energy efficient planning

Some of the design techniques discussed in this report have been used in Ontario. To be effective for energy conservation, they must be applied in a consistent manner. Taken individually they do not necessarily lead to savings.

Energy-conscious community planning presents an opportunity for saving energy. As will be stressed, this depends upon building a suitable home upon each lot. An important consideration is knowledge of the heat requirements of house designs in the various orientations. In other words, subdivision design should be based on siting the available housing in the best possible locations in relation to their energy efficiencies. Other factors – outside the scope of community planning – also help determine space heating requirements. For example, attention must be given to insulation levels, furnace efficiency and the use of thermal shutters or blinds. With these considerations, energy savings due to efficient community planning are further improved.

While energy conservation must be given higher priority in the future, it should not be regarded as a criterion which precludes all other planning priorities. The planning of a subdivision involves considering a wide range of practical opportunities and constraints. Clearly, attempts at energy savings should take into account other development concerns. However, experience to date indicates that energy conservation, while requiring additional fore-thought and care, can normally be achieved without significant cost or maintenance.

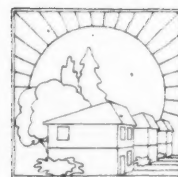
This Handbook focuses on the potential for passive systems, which rely on the penetration of solar energy via windows and the circulation of the heat by natural means throughout the house. This should not be confused with active systems that depend upon expensive collectors and mechanical equipment, or the so-called hybrid systems that use special masonry or water-thermal storage walls, attached greenhouses and internal air-circulating equipment.

All of these solar-heating systems depend upon having unobstructed access to the sun. Therefore, planning for passive energy use also provides for the installation of the other systems.

Several concerns are central to the widespread application of measures which result in a reduction of energy use. One of the most important is the coordination of information regarding the design of energy efficient subdivisions. The material that exists in this field is either too general to be of any practical use, or too site specific to be relevant. Information is often culled from foreign publications, and is not wholly applicable to the Ontario situation. Hence, information reaching developers and planners can be fragmented and not totally reliable. As a result, the whole subject of energy efficiency in subdivisions may be given a low priority in planning considerations. A central source of well documented comprehensive information concerning this topic is therefore of utmost importance.

The parts of this Handbook provide the information to bring into practice energy conserving residential site design. It is intended to promote problem solving by identifying, evaluating, and demonstrating possible solutions.

Basic site design considerations



Introduction

This section reviews the various site planning techniques that can be used to provide greater energy efficiency, while still following accepted subdivision practices. They serve to reduce the need for energy to heat homes in two basic ways:

- Exploiting the passive heat gain available from the sun.
- Reducing the transmission and infiltration heat losses especially due to the wind.

These techniques of energy efficient site design are considered in eight areas:

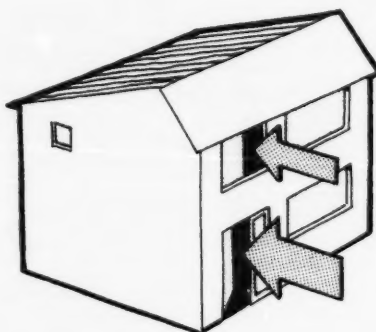
- Dwelling heat load performance.
- Dwelling unit orientation.
- Street and lot orientation.
- Building height and setbacks.
- Dwelling shape.
- Dwelling type.
- Density of development.
- Landscaping.

It must be emphasized that no single solution is appropriate for all subdivisions. The subdivision development process involves making trade-offs between many factors other than the passive solar potential. Site specific considerations may preclude the use of some techniques to conserve space heating energy, or require the implementation of some new and imaginative approaches.

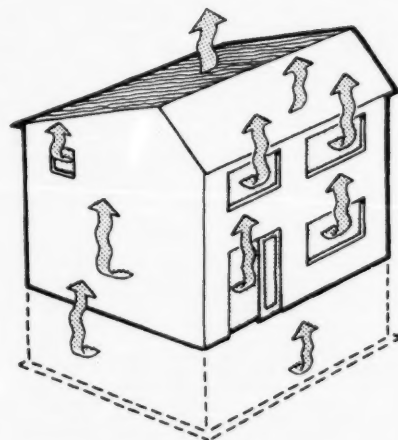
Dwelling heat load performance

The Net Heat Load (NHL) is the energy needed to maintain the interior temperature of a house at a level of comfort generally accepted as 18.3°C or 65°F. This is affected by four factors:

- Transmission heat loss (T), which is the total heat that escapes from a house through windows, walls, ceilings and floors.
- Infiltration loss (I), which occurs when cold air from outside enters a house through cracks or when a door or window is opened.



Infiltration heat loss



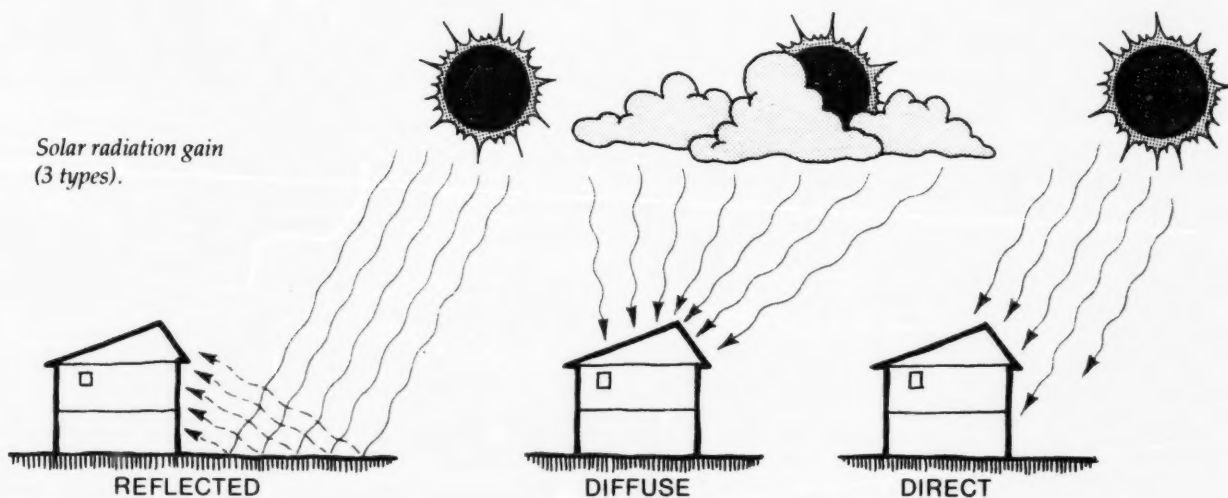
Transmission heat loss



Wild-heat gain

- Wild-heat gain (W), which comes from household appliances, lighting and people's bodies.
- Solar radiation (S), which is the heat gained by a building when sunshine enters through a window.

Solar radiation comes in three forms. Direct radiation from the sun is the most important source for solar heat gain, but diffuse radiation from a cloudy sky and reflected radiation off other surfaces also can contribute to heat gain in a house.



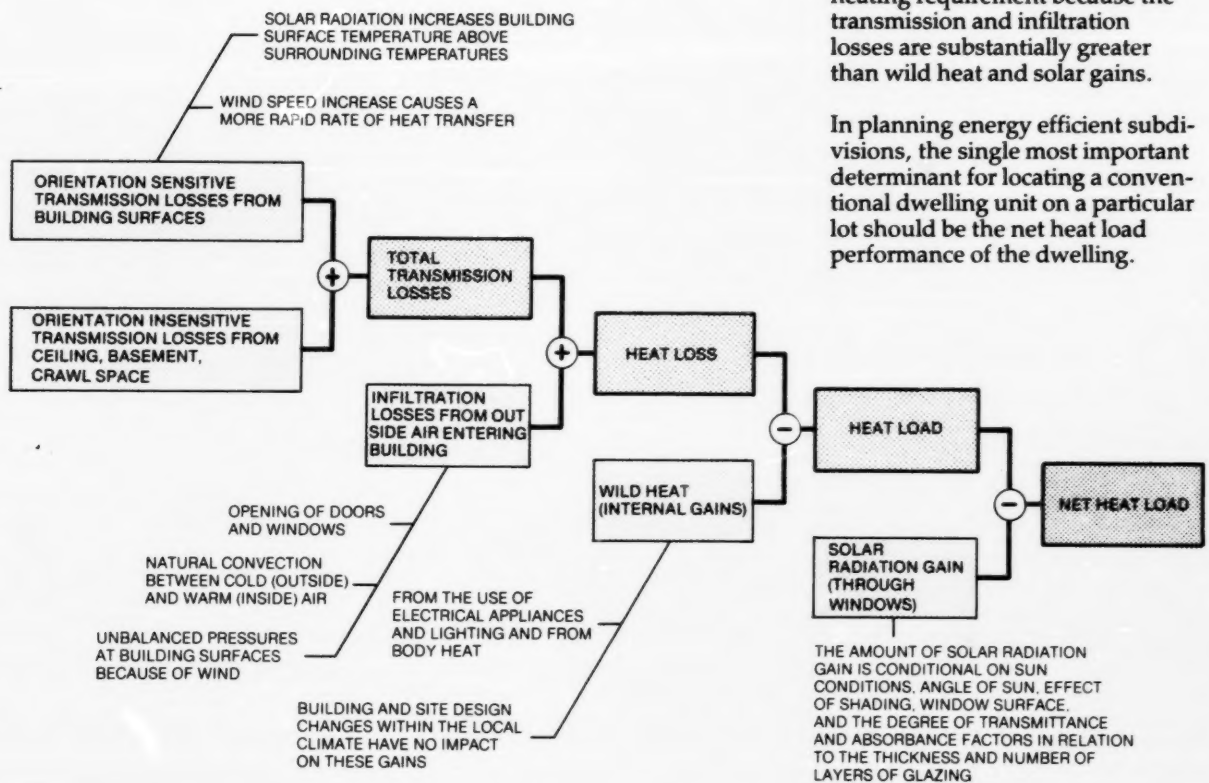
Solar radiation gain
(3 types).

The amount of energy needed to heat a building, then, can be expressed by this simple equation:

$$NHL = T + I - W - S$$

During the colder months, virtually all homes in Ontario have a heating requirement because the transmission and infiltration losses are substantially greater than wild heat and solar gains.

In planning energy efficient subdivisions, the single most important determinant for locating a conventional dwelling unit on a particular lot should be the net heat load performance of the dwelling.

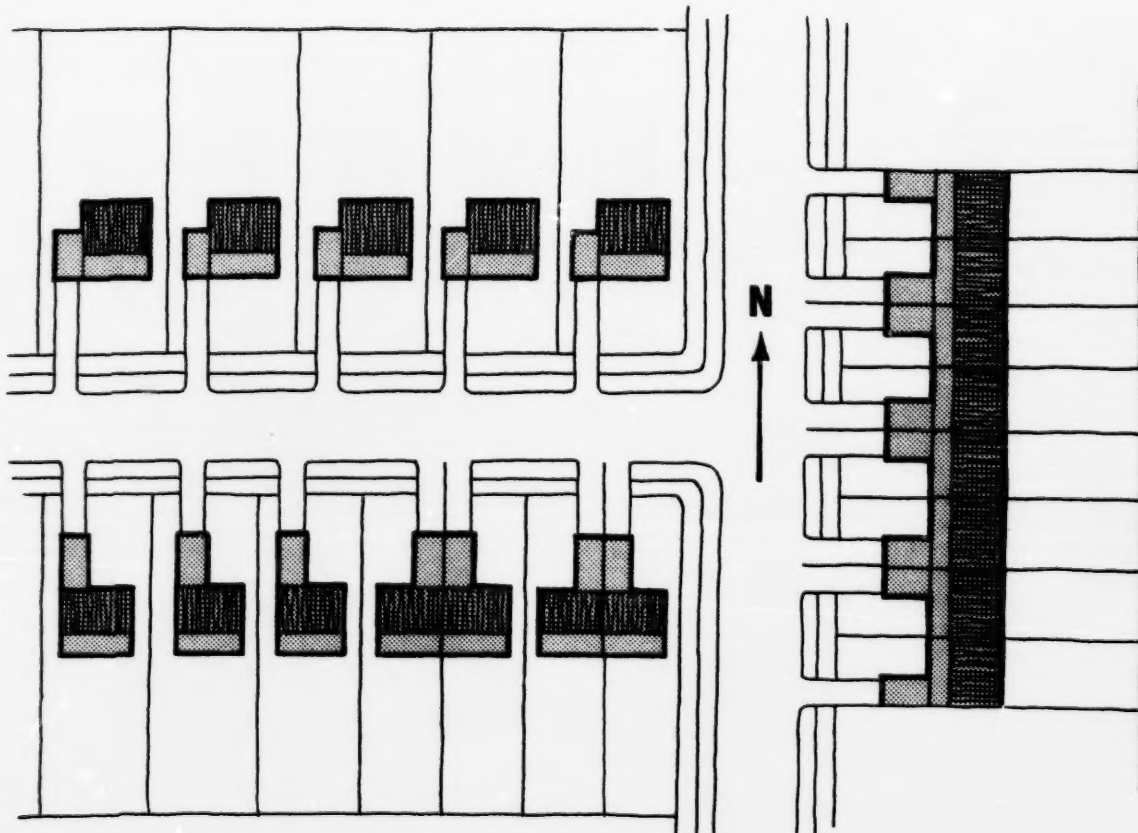


Basis of the net heat load calculation.

It should be recognized that certain dwelling types (singles and semis) generally have a greater potential than others for heat gain from the sun, and for transmission and infiltration heat losses due to the wind. Furthermore, this potential is directly affected by the orientation at which the unit is sited.

Wherever possible in preparing a subdivision plan, the dwelling types should be matched to the lots with the most appropriate orientation in order to minimize the overall heating requirement for the site. For example, the potential for solar heat gain is generally much greater in single

detached houses than with row-houses. Therefore these detached dwellings generally should be located on east-west streets with good southern orientation, while the rowhouses could be located on the north-south streets. Similarly, wider lots provide more flexibility in placing garages to minimize overshadowing. Therefore, the wider lots should be located on the north side of east-west roads in preference to the south side.



Dwelling types are matched to appropriately oriented lots.

Dwelling unit orientation

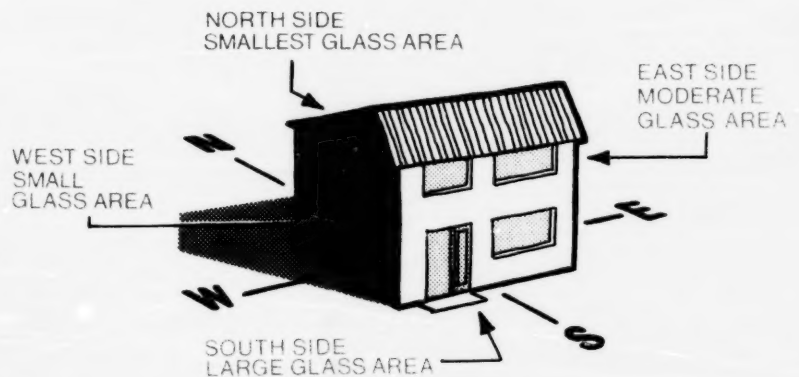
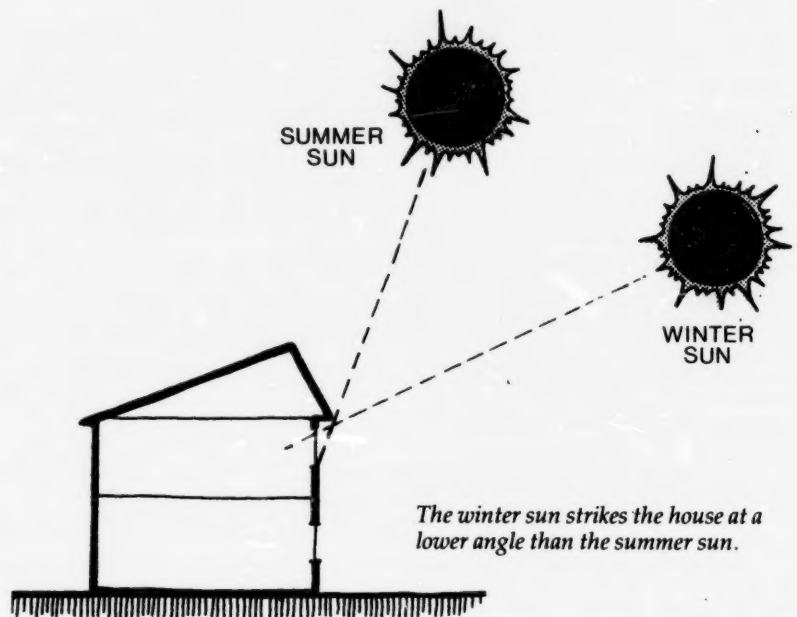
Proper orientation of dwelling units can reduce energy demand in two ways:

- Providing access to solar radiation.
- Reducing heat losses caused by prevailing winter winds.

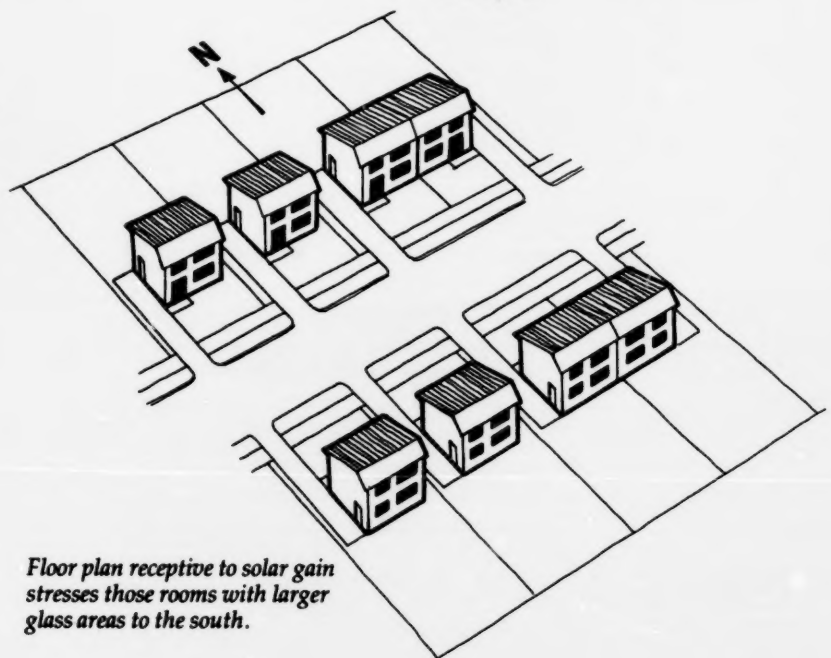
In Ontario, the side of the dwelling that best utilizes the sun is the south. The east and west also can benefit, but to a much lesser extent. At the very least, in a conventional house the area of glass should be reapportioned so that the larger glass area is located on the south wall of the building.

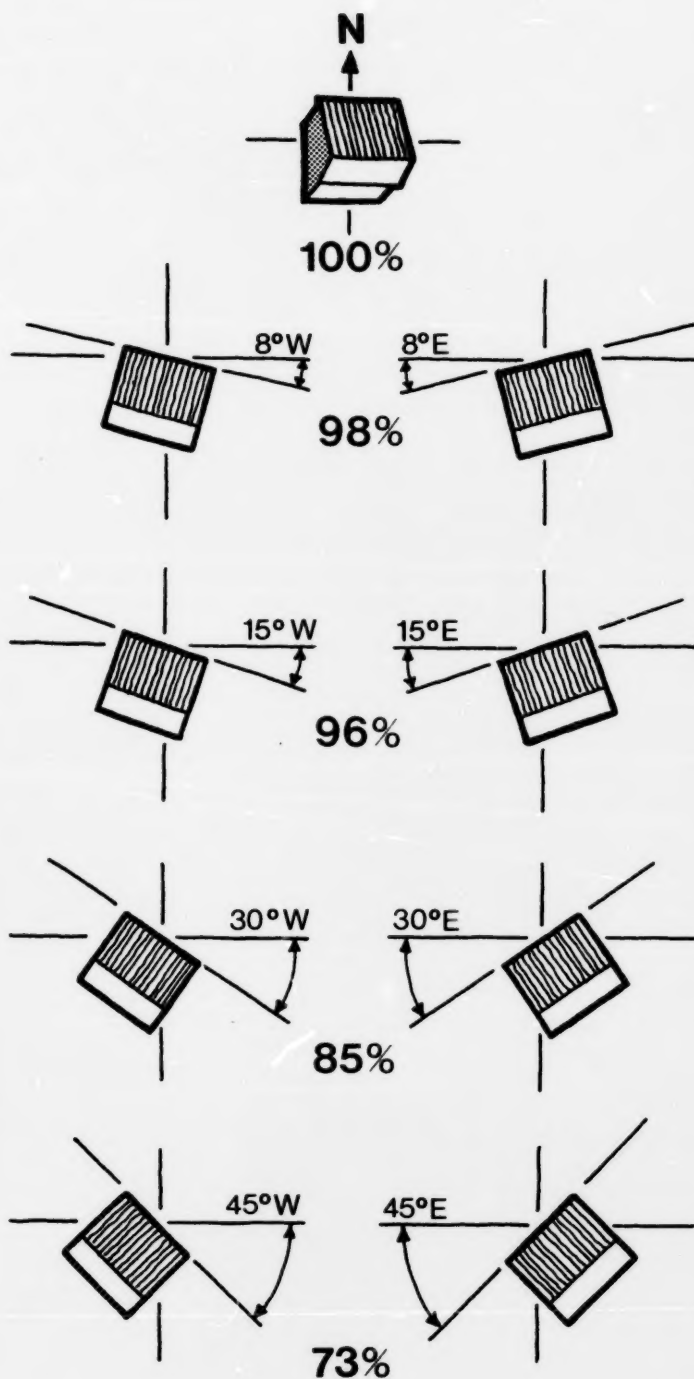
The prevailing winter winds in this Province are generally from the north-west. A minimum amount of north and west facing glass area can reduce infiltration losses (heat loss due to outside air flowing indoors through cracks). Transmission losses must also be considered when deciding on window placement.

The dwelling units should be designed to take full advantage of solar exposure. It is beneficial for rooms generally having the largest window areas, such as living and dining rooms, to face south. Those spaces that can benefit from the early morning and late afternoon sun, such as the bedrooms and kitchen, also should be located appropriately. On the other hand, rooms like bathrooms that do not require a high degree of natural light are best placed along the north face.



Largest glass area is preferred on the south face.





A range of orientations from due south are possible while still providing excellent solar exposure. Dwellings can be oriented 15 degrees east or west of due south without significantly reducing the potential for solar heat gain. When sited 30 degrees off due south, the loss of potential direct solar radiation amounts to about 15 percent. Solar gains are progressively reduced as dwellings are shifted further away from due south.

As a general rule, an orientation slightly east of south is the preferred one for solar gain. This orientation increases solar radiation in the morning when the ambient temperatures are lower, and reduces radiation in the afternoon when the outside temperature has risen.

Given the range of possibilities, however, the best orientation on a particular site may depend on local conditions. In areas with morning mist, for example, a building orientation slightly further to the west may be preferred because the early morning sun is obscured.

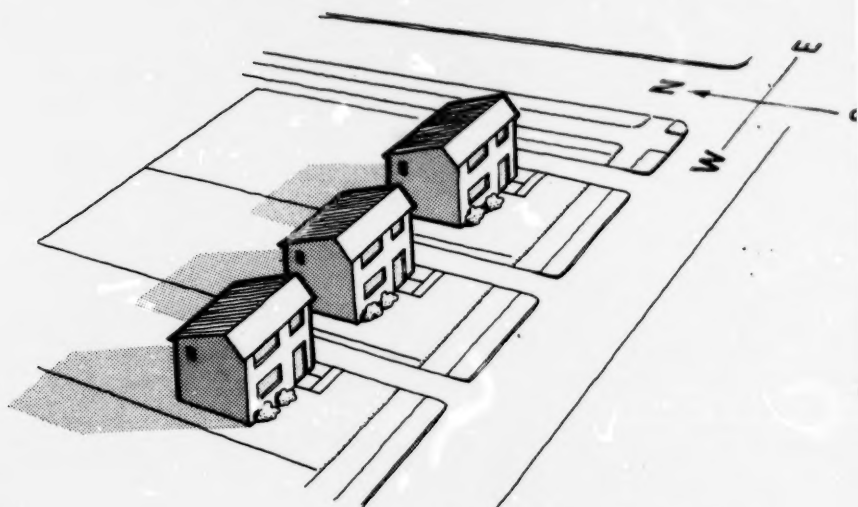
Direct solar radiation gain (which is one component of the net heat load calculation) diminishes as house is oriented away from due south.

Street and lot orientation

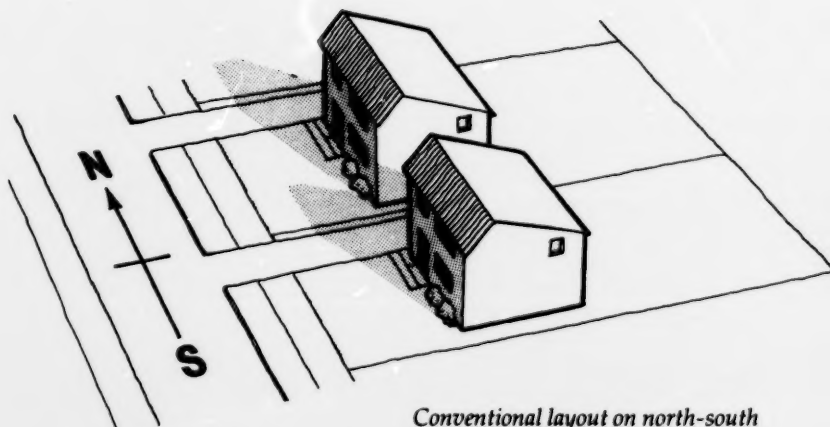
The orientation of the lots is a major design concern in an energy efficient subdivision plan, and this is directly related to the orientation of the streets. The two together can significantly influence the degree to which the dwelling units can receive solar radiation.

To best provide for solar access to the lots streets should be oriented in a general east-west direction. For those streets that cannot be so arranged, it may be possible to modify the lot configurations or the dwelling design to provide solar access.

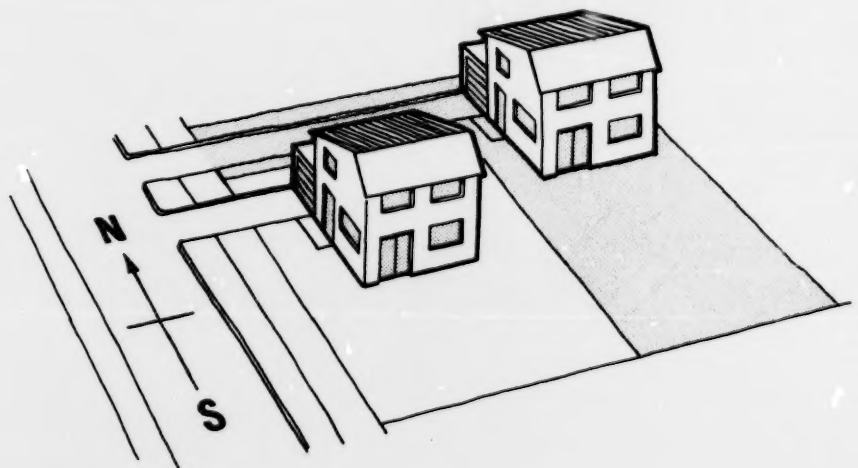
One useful way of achieving proper orientation on north-south streets or at corners is by utilizing specially-designed lots. This technique employs a flag-shaped lot behind a more conventional lot, with only a narrow street frontage for the driveway. As a consequence, the dwellings can be offset from each other to limit overshadowing. The dwellings on these special lots may be either detached or semi-detached.

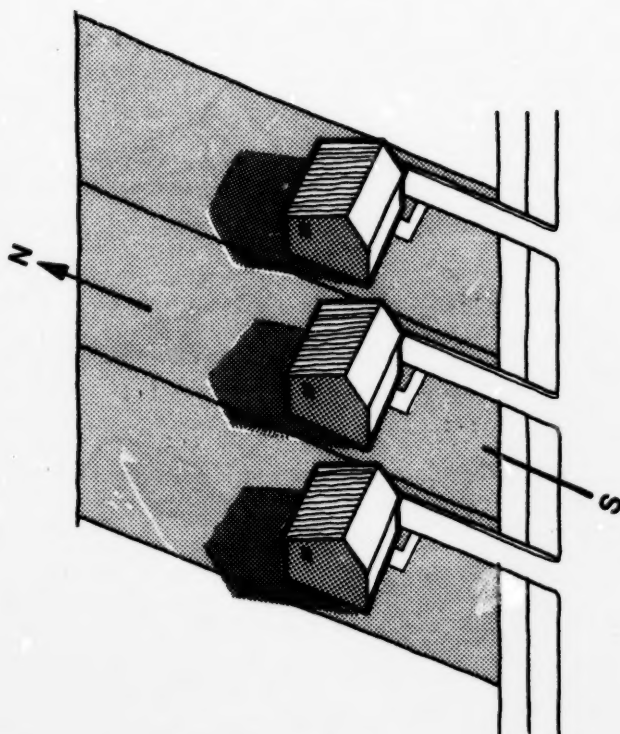


East-west street pattern is most appropriate for purposes of passive solar heating.

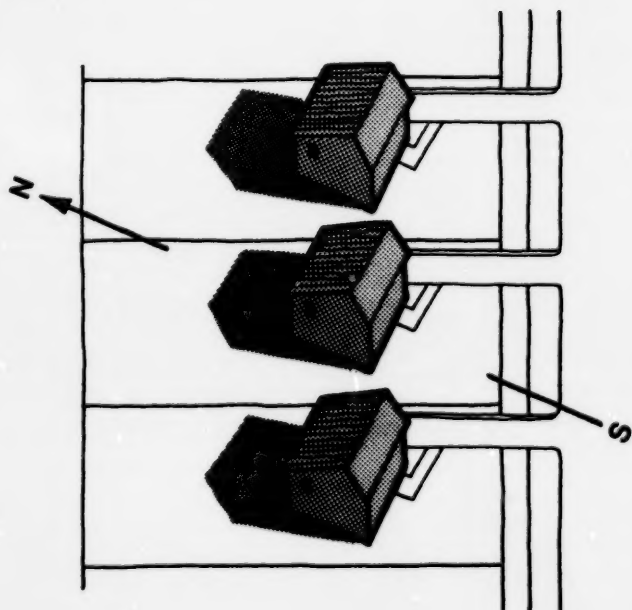


Conventional layout on north-south streets (above) limits reception of solar radiation otherwise available in 'flag-shaped' configuration (below).





Alternatives which increase potential for solar access include lot skewed from street (above) and house skewed on lot (below).



For those houses located on streets that run diagonally to the east-west axis, other solutions for a southern exposure are possible. One approach is to skew the lot so that the side lot lines are more or less in a north-south direction, and not perpendicular to the street. Houses on these skewed lots are parallel to the lot lines. This arrangement allows the larger glass areas of a house to face south.

Alternatively, the houses only are turned askew on the lots which are conventionally sited in relation to the street. This arrangement is difficult on narrow lots where conventional side yard standards are required, and it is likely to be rarely used.

In all of these approaches some overshadowing may occur either late or early in the day, but the main potential for solar heat gain is provided by the unobstructed southern facades at other times.

Building height and setbacks

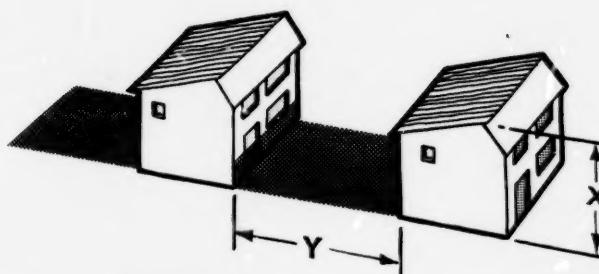
In many cases, conventional zoning standards in general use in the Province may be adequate to meet the goal of solar access to south walls of dwellings. This is particularly true for low profile dwellings (for example, single detached) which, in relation to their height (and therefore shadow projections), are well separated from neighbouring dwellings.

When adjustment to existing standards are found to be necessary in order to ensure at least a minimum amount of direct solar radiation, four factors are considered:

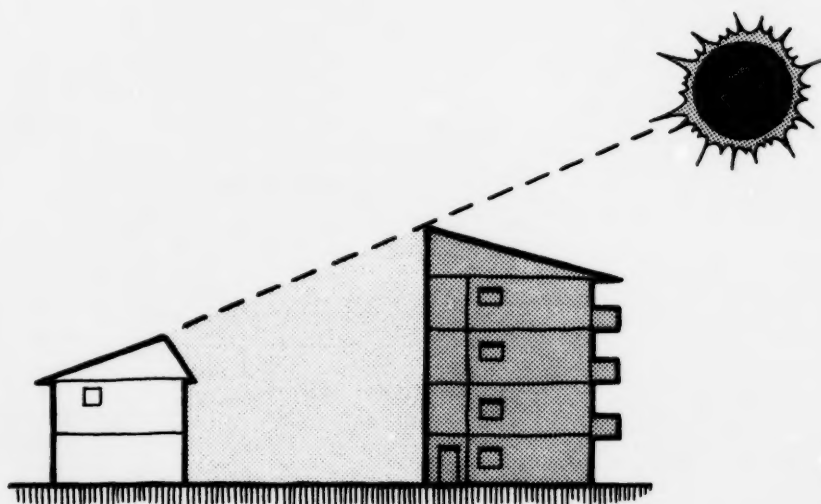
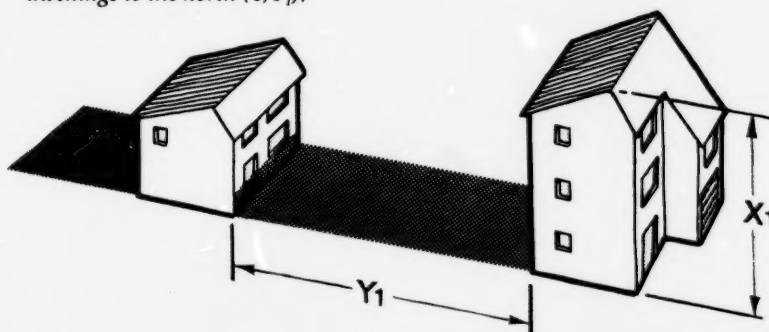
- Maximum building height.
- Lot dimensions and setbacks.
- Slope gradient and direction.
- Site latitude.

Reducing the height limits of buildings has the effect of reducing shadow lengths and providing greater flexibility in siting neighbouring buildings. The height reductions need not be drastic, but are dependent upon the projection of shadow length, the distance between dwellings and the topography of the particular site. These criteria determine the maximum building height which still allows south wall solar access.

A maximum height limit could be determined for those multi-family buildings which lie to the south of a detached housing development, in order to prevent shadowing of the detached dwellings.

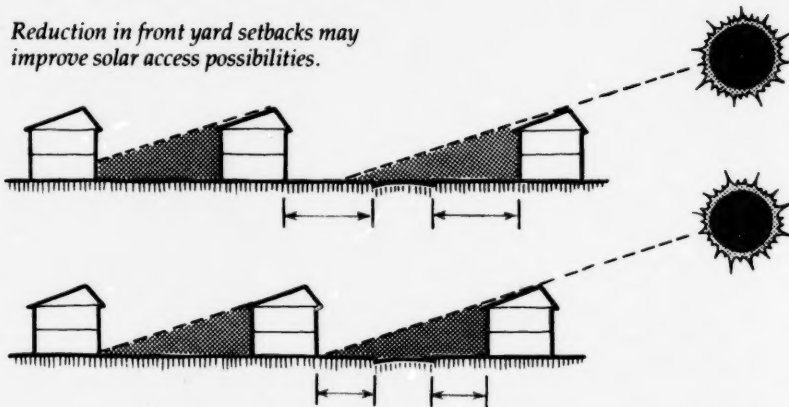


Height of shadow casting dwelling (X, X_1) influences the necessary separation distance to neighbouring dwellings to the north (Y, Y_1).

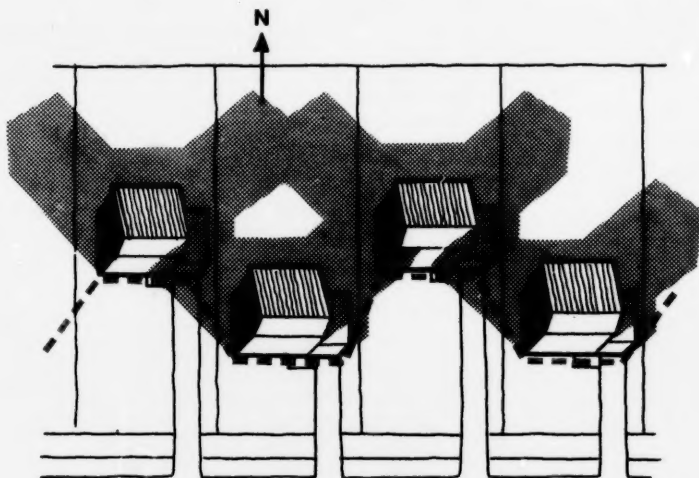


Taller multi-family dwellings may preclude solar access during the coldest part of the year to neighbouring shorter dwellings.

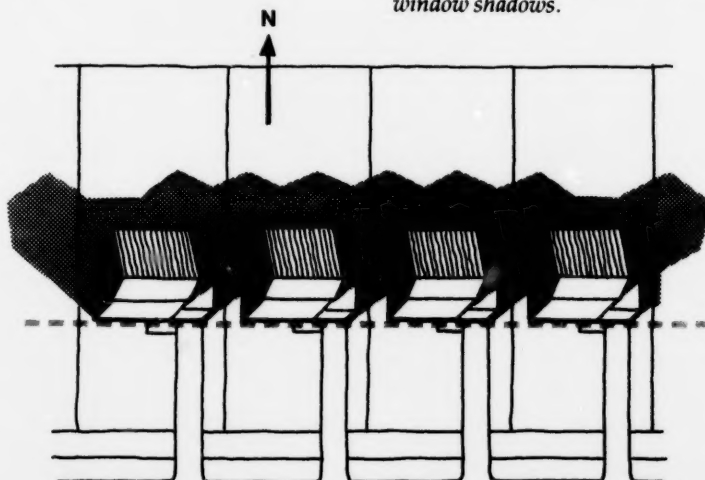
Reduction in front yard setbacks may improve solar access possibilities.



Lot measurements have an influence of whether one dwelling shadows another. For instance, on east-west oriented streets, separations between the fronts of dwellings (front yards plus road) may be greater than those at the rear of the dwellings. Hence, those dwellings on the north side of the street may have a greater potential for solar access than those on the south. In order to improve the situation of south side dwellings, front yard setbacks could be reduced, while increasing the rear yard setbacks. This results in a more equitable arrangement of all dwellings on that street.



Staggered dwellings cause south window shadows.



Uniform setbacks permit solar access.

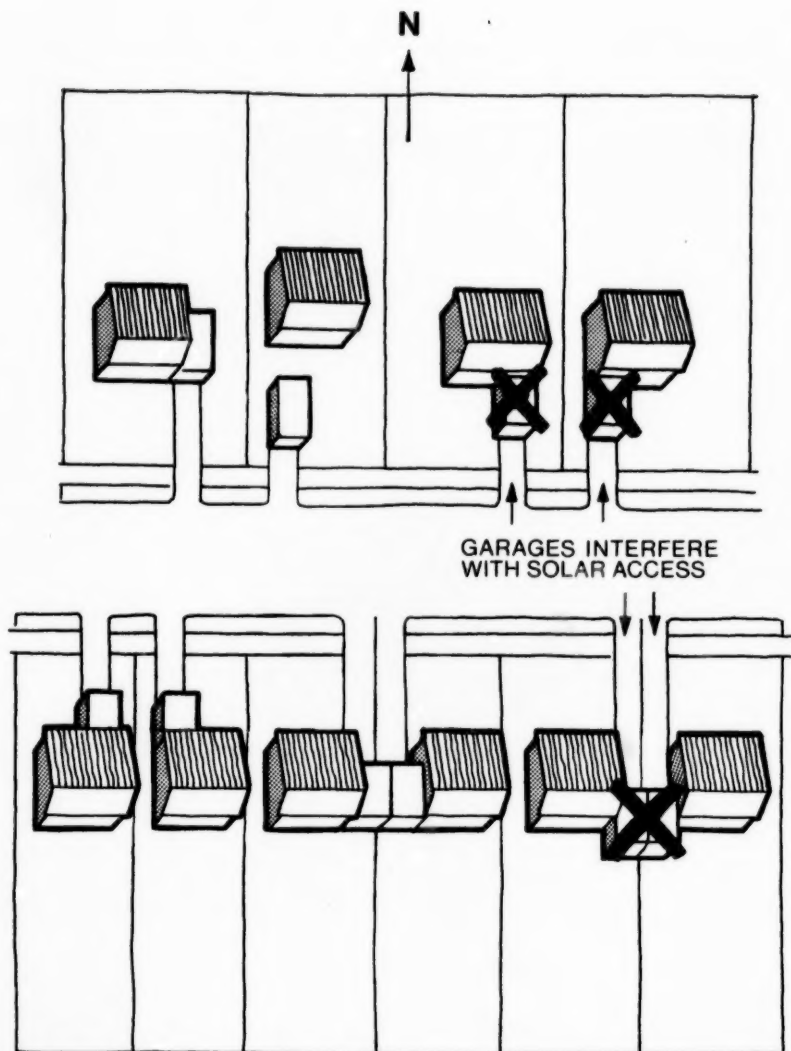
This technique cannot serve its purpose for those dwellings on north-south oriented streets, as the right-of-way does not provide the same protection for solar access. As housing on these streets cannot adequately profit from solar radiation gains (except when unconventional lot configurations are used), rowhouses and semi-detached dwellings are best suited, since they derive the energy benefits from having one or more attached walls.

Conventional practice permits the staggering of buildings from front and rear lot lines. In terms of space heating by solar access, this stagger should be related to the shadows created during the coldest months. As lots and distances between houses become smaller, care should be taken to avoid undue shading.

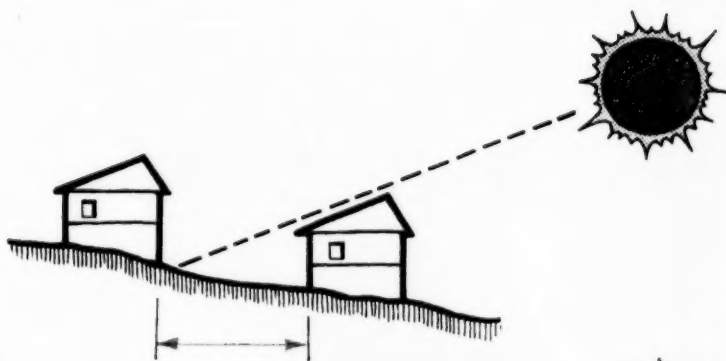
The placement of the garage on a lot determines, to a large extent, the amount of glass area in a given dwelling type that is potentially exposed to the sun. The south side of east-west oriented streets generally provides the best opportunity for all dwelling types to attain maximum passive solar gain, since garages can be sited to the north or sides of the dwellings without obstructing the sun.

The north side of east-west streets can also provide good solar access to single detached and semi-detached dwellings, if the lot width provides enough space to locate the garage to the side of those dwellings. When lot width is insufficient, and lot depth sufficient, garages should be placed to the south of and sufficiently detached from the dwelling units to allow for the penetration of sunlight into the house.

A problem may arise in the rowhouse situation. Care should be taken when siting two-storey rowhousing on the north side of an east-west street, since the location of the garage normally interferes with solar access to the already limited glass area. Detached garages to the south of the dwellings may alleviate the problem. Alternatively, three-storey rowhousing, with its additional height and integrated garage, has an increased potential to receive solar radiation, making it better suited for north side locations.

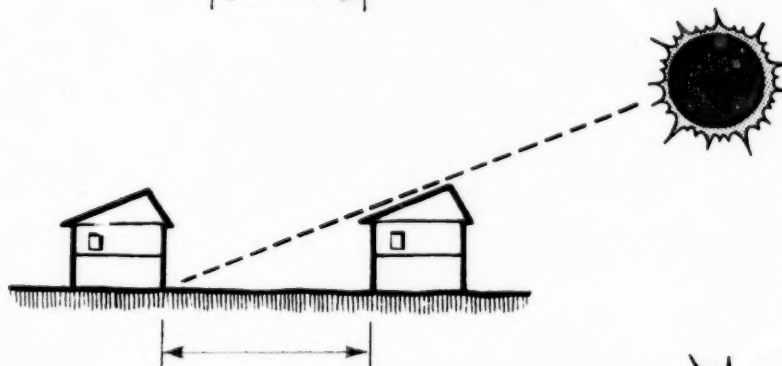


Garage placement should not result in shadows falling on south wall of house.

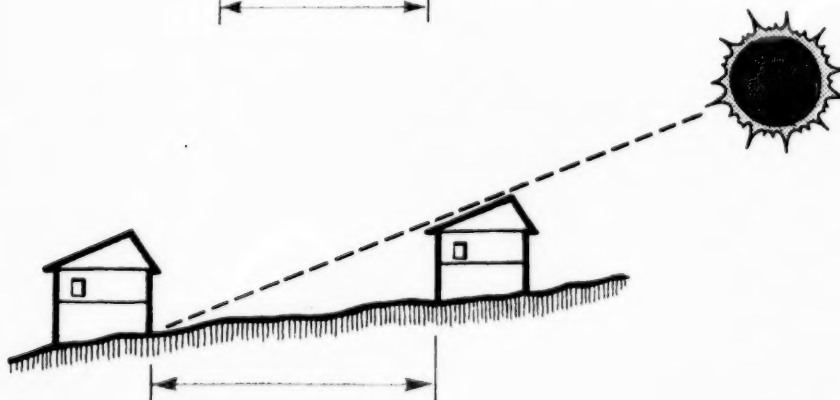


The slope of the site will affect the shadow cast. Dwellings on the north side of a hill will have longer shadows than those on the south side. North-facing slopes of greater than five degrees may preclude the possibility for solar access in the coldest part of the year due to the low altitude of the sun.

South-facing slopes generally are more suitable for development than north-facing ones. Because the shadows lengths are shorter, the dwellings can be spaced closer together without restricting solar access. These slopes are also generally better protected from the prevailing winter winds.



The final major factor that must be considered in determining the shadow is the latitude of the site. For sites further to the north, the winter sun is lower in the sky, and requires greater distances between buildings to provide solar access.



Effect of slope on shadow lengths.

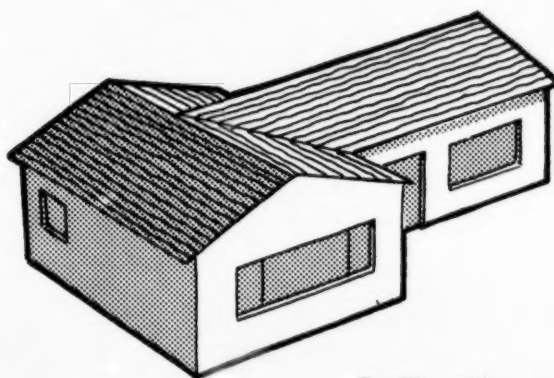
Dwelling shape

An efficient house form is one which is of such a shape as to minimize heat losses. These transmission and wind infiltration losses are reduced when the house shape is regular – that is, the exterior surface area is the least for a given volume.

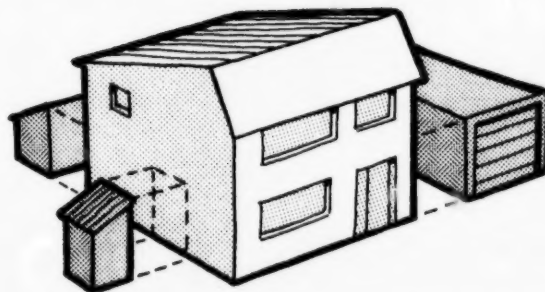
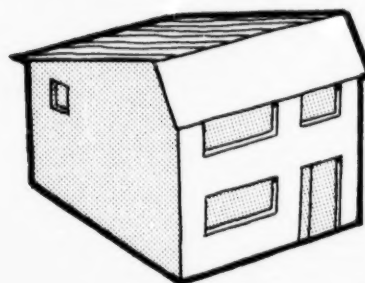
To this compact shape, ancillary elements may be added as long as they are unheated and not integral to the dwelling. Garages and storage sheds attached in this way, for example, serve to insulate the adjoining wall. Properly located, these external elements also can provide a buffer to prevailing winter winds. Care must be taken, however, to ensure that these elements do not shade south facing windows during the heating season.

Integral elements that add to the heated perimeter of a dwelling, on the other hand, serve to increase the external wall area of that dwelling. These extra walls augment the heat losses, thereby increasing the dwelling's heating needs.

When designing a house, the potential for retro-fitting active solar collection panels should be considered. The roof can be set at an angle to provide the maximum solar exposure. The optimum angle of the south facing roof is determined by adding about 15° to the latitude of the site. For example, at North Bay, which is at approximately 46° north latitude, the optimum angle is 61° from horizontal.

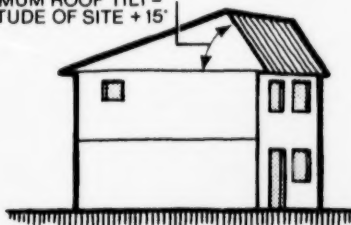


Dwelling with many wall faces (above) is less efficient than a simple dwelling shape (below).



Energy efficient dwelling has attached, not integrated, ancillary elements.

OPTIMUM ROOF TILT =
LATITUDE OF SITE + 15°



Potential for active solar heating panels exists with an appropriately angled roof.

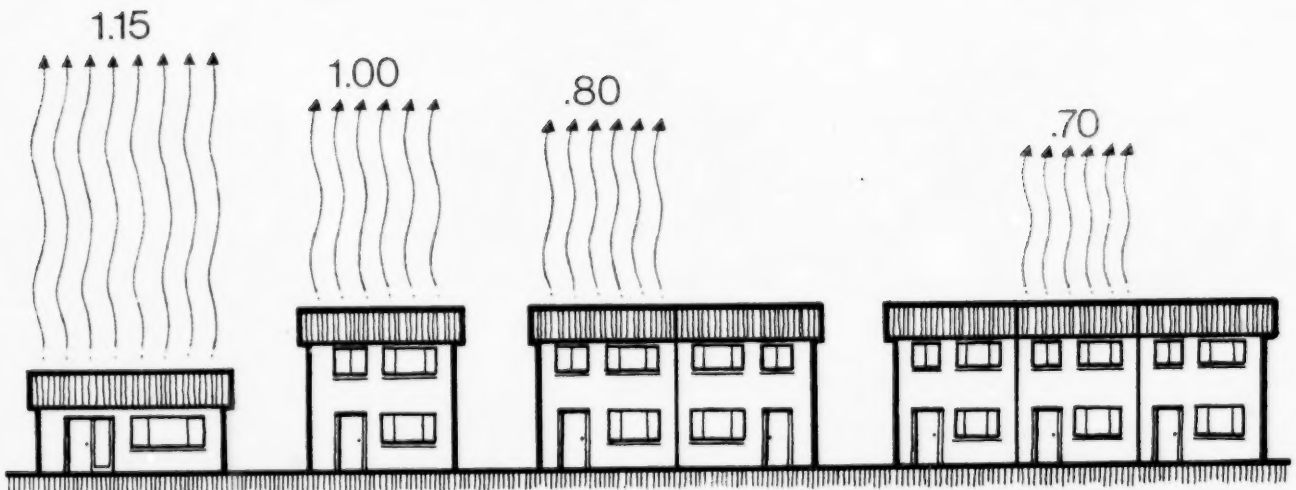
Dwelling type

The heat loads of the basic dwelling types vary because of their different exterior surface areas.

When comparing various dwelling types of equal floor area, the bungalow generally is the least efficient in terms of heat loss due to its relatively large roof area. The heat load of the equivalent two-storey detached dwelling, for example, can be 15 percent less because it has a more compact shape and a correspondingly smaller ratio of roof to floor area.

All attached dwellings benefit substantially from their common walls. A semi-detached unit may be 20 percent more energy efficient than a detached dwelling of equal floor area. Similarly, an interior rowhouse with two common walls uses 30 percent less heating energy than the detached house.

Because of the built-in thermal advantage of rowhouses, it is less critical that they are located on east-west streets. Therefore, they can be logically sited on any north-south street. On the other hand, detached units should be located on lots with southern orientation because these units benefit more from solar heat gain.



Heat losses are partly a function of roof to floor area ratio and the number of common walls.

Density of development

Densities should be flexible enough to accommodate those factors which are most important when considering the efficient use of energy – transit feasibility, compactness of development, solar access, and energy sensitive landscaping.

In most cases, density of development has an inverse relationship to the amount of energy consumed. Due to the inherent form of various dwelling types, higher densities lead to a reduction in energy expended for space heating requirements. That is, multi-

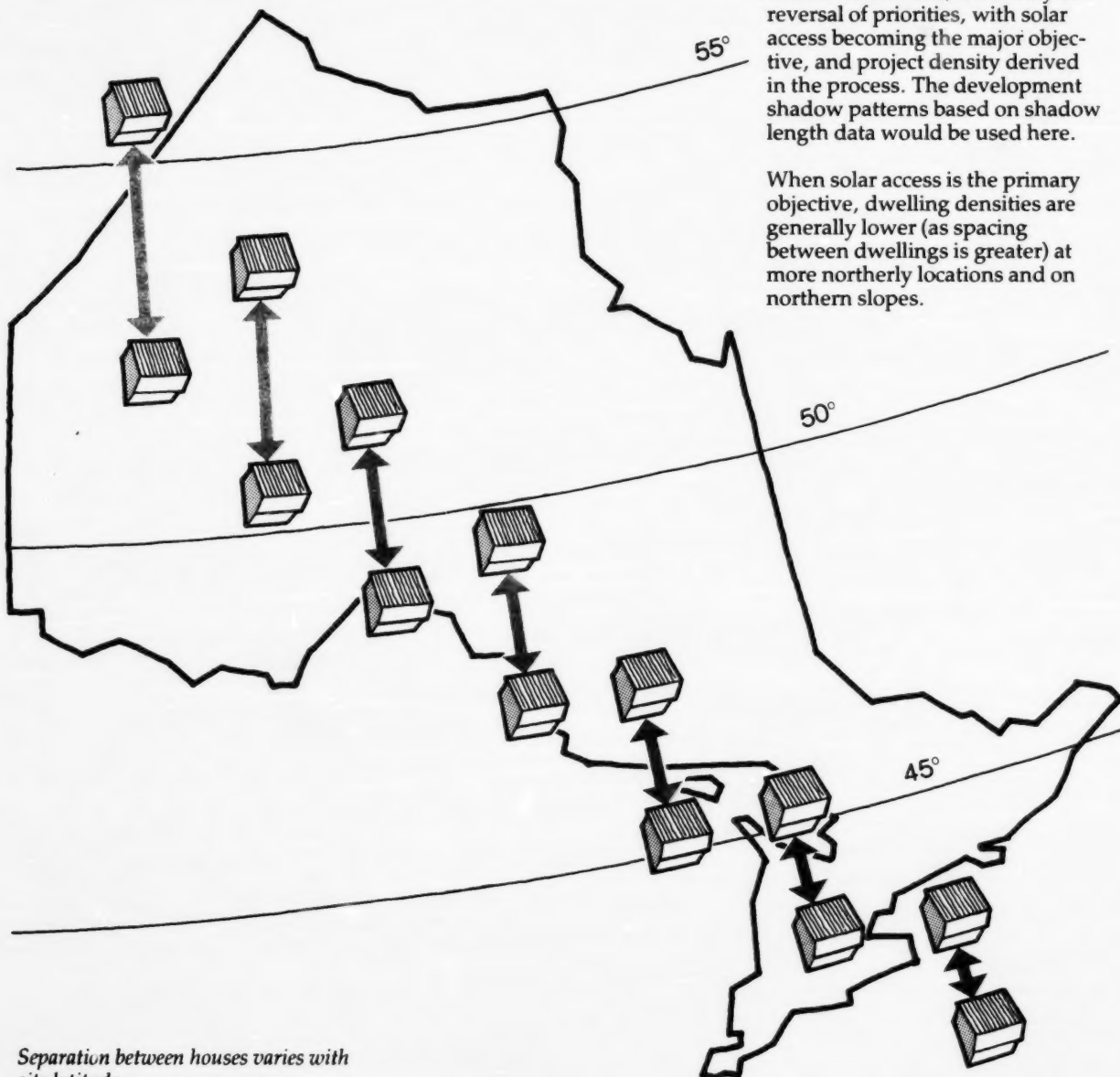
family housing units (usually associated with higher densities), with such characteristics as common walls, floors and ceilings, are more efficient than single detached units (characteristic of lower densities) which require a greater area of exterior wall area to enclose an equal amount of floor space.

Increases in density may result in a reduction of solar access for some or all dwellings, depending on the method of development. On the one hand, it may be decided to strive for a certain density and then arrange the development to minimize shading

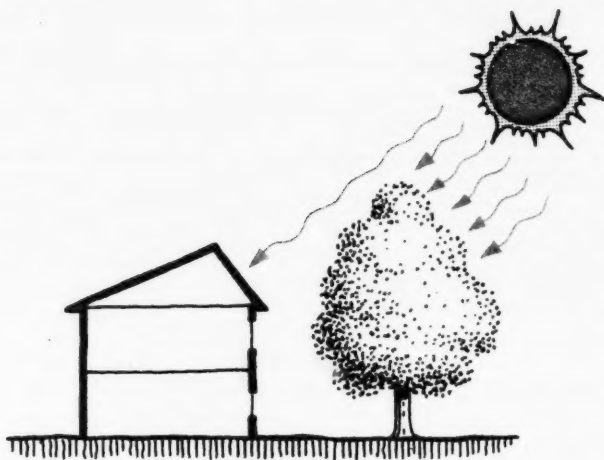
and maximize solar radiation to south walls. This may result in some dwellings achieving less than optimal south wall solar access. When housing densities increase to what is considered to be medium density development, there is the distinct possibility that shadow projections could cause solar access problems. Some dwelling units are denied solar access for certain hours during the 9 a.m. to 3 p.m. period. Tradeoffs with other priorities (such as privacy, or the use of more dwellings sharing common walls and using less energy) have to be considered.

On the other hand, there may be a reversal of priorities, with solar access becoming the major objective, and project density derived in the process. The development shadow patterns based on shadow length data would be used here.

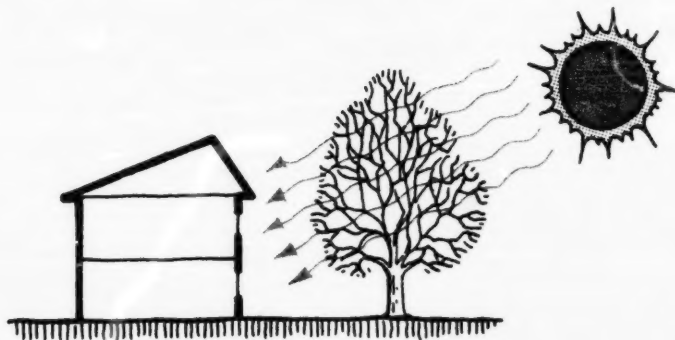
When solar access is the primary objective, dwelling densities are generally lower (as spacing between dwellings is greater) at more northerly locations and on northern slopes.



Separation between houses varies with site latitude.



Deciduous trees provide summer protection from and winter access for sun.



Landscaping

Trees, shrubs and grass, if properly sited, have a beneficial effect on the energy requirements of a dwelling. In winter, trees can reduce wind speeds and consequent heat losses. In summer, evergreen and deciduous trees block unwanted solar radiation, and other ground cover absorbs much of the solar radiation falling on it, which serves to lower day-time temperature.

Deciduous trees perform the function of restricting excess summer sun from south facing windows in early morning and late afternoon. They are also appropriate to protect west oriented windows from receiving too much of this late afternoon summer sun, protection which conventional overhangs cannot always adequately provide.

When deciduous trees lose their leaves in fall (which approximately coincides with the start of the heating season), solar radiation can begin fulfilling the space heating needs of a dwelling. Even during this period however, the bare branches can block a certain amount of sunlight from reaching south facing windows.

When choosing deciduous tree species, therefore, consideration must be given to their dual function – that of alternately blocking and allowing solar radiation during the year. Some characteristics to look for are density of twig configurations, tree form, and rate of and potential for growth.

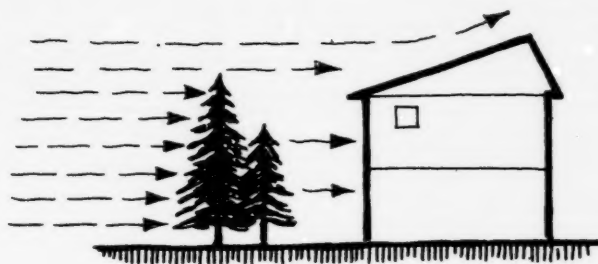
The major role of evergreen trees is to provide shelter from winter winds which prevail from a general north-westerly direction.

During the heating season, wind characteristics, such as speed, direction, frequency and duration of the wind striking the dwelling, have an undesirable impact on transmission and infiltration heat losses. The magnitude of this impact varies according to those factors. Evergreen trees reduce these effects of wind, and subsequently, heat losses from the dwelling.

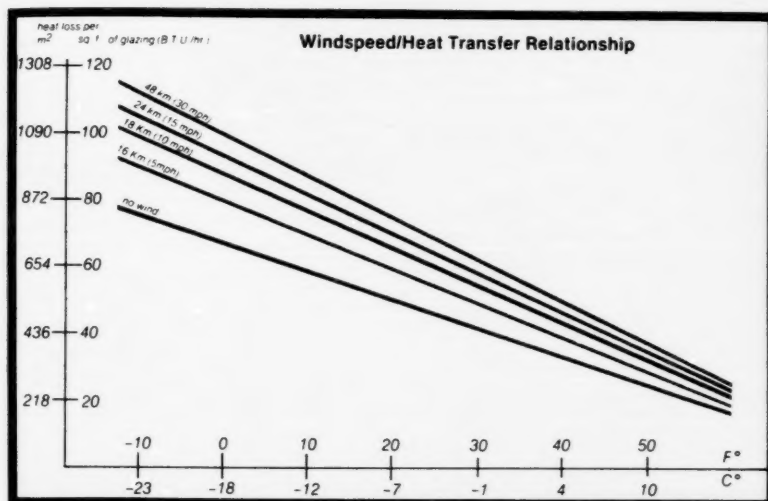
Recent research indicates that the overall infiltration rate is dominated, at a time of extremely low temperatures and calmer winds, by the temperature. This principle suggests that the conventional use of evergreens as a barrier to wind infiltration may be somewhat less than formerly supposed.

Also to be considered is a layer of still air that surrounds a dwelling unit and which serves as an insulating barrier. Unhindered winds disturb this barrier, making the dwelling more vulnerable to heat losses, thereby increasing the dependence on mechanical heating systems. Landscaping close to the north wall helps preserve this beneficial dead air space.

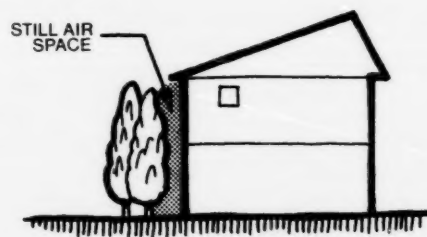
Shrubs, grass and small plants absorb solar radiation in the summer, and prevent reflective heating. The need for artificial cooling is reduced further because of the cooling effects caused by ground cover transpiration and evaporation.



Evergreens reduce the negative effects of wind.

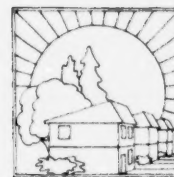


The stronger the wind on a pane of glass, the greater the heat loss through the window.



Still air provides insulating barrier.

Background to the parts of the handbook



Introduction

Each of the subsequent parts is a "how-to" guide to one of the design and procedural aspects of saving space heating energy in subdividing land. The following summaries of these parts indicate the scope of the work involved.

The subdivision process for energy efficient site design

Selecting the most suitable house design for the lot is a crucial step for energy conservation in the development process. All of the previous planning efforts for conservation could be frustrated by a builder who develops a house that is inappropriate to the particular solar and wind conditions of the lot.

The objective is to provide a method that allows the builder to conserve energy by matching the house to the lot and local climate while working within the bounds of existing legislation.

Shadow calculations for site planning

The solar radiation received by a house during the coldest part of the year is affected by the shadow patterns cast on the house by other buildings, vegetation and parts of the house itself. A number of factors must be considered, including the position of the sun in the sky, the size and position of the obstruction, and the latitude and slope of the site.

The objective is to provide methods of determining shadow lengths, which incorporate all of these factors and are readily usable in the design of subdivisions.

Principles and quantification of residential space heating energy requirements

Understanding of the space heating characteristics of a house is fundamental to any energy conservation program. The site planner needs to ensure that the house selected for a particular lot makes the best use of the solar energy available. In addition, prospective home buyers are likely to be increasingly interested in comparing the potential energy costs of the various models.

The objective is to present understandable, reliable, and readily usable methods of estimating the space heating energy requirements of a house design in various orientations.

Protection of solar rights

Solar access is an increasingly important issue not only because of a direct intention to conserve energy, but also because of the increasing physical barriers to solar access resulting from higher densities of residential development. A further consideration is the need to safeguard access to future active solar equipment.

The objective is to examine the mechanics of solar access and the existing material on related legislation, and to investigate the best means of attaining solar access by way of present planning legislation.

The effect of energy-conscious planning on street and house design

The need to conserve residential space heating energy could lead to changes in house design, especially in window arrangement, internal layout and roof shape (for the addition of any future active solar equipment). Similarly, the appearance of the streetscape could be altered by more care in varying setbacks, reduced north-facing windows, longer east-west streets and other changes. There is some concern that these changes could affect the marketability of energy-conserving homes.

The objective is to illustrate the potential changes to house design and residential streetscape that could be caused by planning for energy conservation, and to set out various acceptable alternatives that are not a deterrent to marketing.

Basics of passive solar heating

Heating a house by the sun is not a new venture. The practice has been somewhat dominated by active and so-called hybrid solar systems. The former system requires relatively expensive collectors and mechanical equipment, and has suffered from high cost, maintenance problems and a poor cost-benefit ratio. The latter system, which involves such extra-cost items as masonry or water-thermal storage walls, attached greenhouses and special internal air-circulation systems, has received some adverse reaction because of the additional cost and the marketing resistance to the mass storage walls blocking the view from the principal window. Passive systems rely on the penetration of solar energy into a house via the windows, and the flow of such energy by natural means such as radiation, conduction and convection.

The objective is to highlight the basic elements in a passive solar-heating system, and provide an understanding of the concept of solar gain. Particular attention is paid to the ability of the normal house, with and without some marginal improvements, given proper window arrangement and orientation, to make use of solar energy for space heating.

Landscaping for energy conservation

Landscape planning for energy conservation is concerned with the provision within a residential subdivision of natural features (such as vegetation), and man-made features (for example, groups of buildings, fences, and berms). Landscaping should seek to achieve a reduction of the cooling effect of the wind in the heating season, and a shading of houses for cooling in the non-heating season.

The objective is to provide information on the vegetation that can be grown in Ontario, and the effects of vegetation on solar radiation, wind, air temperature, and precipitation (especially snow accumulation). Care is taken to examine the effectiveness of evergreens as a wind barrier on very cold days.

Local climate data

The application of climatic data as a means of energy conservation is neither well documented nor practiced. There is a wealth of information for Ontario that needs to be identified and supplied so that new residential subdivisions can be designed to make use of the local climate.

The objective is to identify the relevant climatic data for various localities throughout the Province, and define the relationship of this information to subdivision planning.

Sample house designs and their relative anticipated heat loss

The selection of the house is important in the development of new subdivisions planned to save space heating energy by way of site design. There is a need for a better understanding of the relative merits of conventional designs in terms of energy requirements and orientation.

The objective is to create a small folio of basic house designs for detached, semi-detached and row-housing that shows their relative space heating requirements in various orientations. Conventional house plans are included, together with minor amendments to make them more energy efficient. Also included are some newer plans that, with only marginal additional costs, have been designed for passive solar heating. Comparison with the designs in this folio provides a basis for selecting the most suitable house for a lot.

Transportation energy conservation principles in site planning

The major energy savings for transportation in land use planning are obviously to be found by decreasing travel by way of increased density, more mixed-use development and more opportunity to decrease the work - home travel distance. Within a low-density subdivision there are fewer opportunities to conserve transportation energy because of the uniformity of the land use, relative lack of density variation, and the shortness of the internal travel distances.

The objective is to determine the design principles that will provide the shortest travel distances within the subdivision, least interruption in the traffic flow, and the relationship of the house types to any available public transit.

The effect of energy conservation on residential development standards

Potential savings for residential development by way of new planning and servicing standards were explored in an earlier study by the Ministry of Housing. These significant savings resulted from changes in both engineering (storm drainage, sanitary and water service connections, and road cross-sections) and planning standards (mainly smaller lot sizes). Standards for energy conservation by way of site planning have several relationships to these changed standards for residential development. These concern increased densities (with their effect on sheltering and shading), street and lot orientation for solar access, landscaping and house type and design.

The objective is to produce an understanding of changed residential development standards that can be used by builders, developers and planners in new subdivisions to conserve energy as well as reduce development costs.

Solar access in medium density ground-related housing forms

Density is a key factor in implementing energy conservation in new residential development. Because of the shared walls and floors, higher densities generally have lower heating requirements than lower densities. Higher density, however, even in ground-related housing can have the disadvantage of reducing solar access by increasing the potential for overshadowing.

The objective is to show design solutions that have a satisfactory trade-off between the loss of solar heat gain due to the increased shading and the reduction in heat loss due to the shared surfaces.

Official plan statements, zoning by-laws and subdivision agreements for energy conservation by way of site design

The legal tools for integrating energy conservation into the subdivision development process are based on official plans, zoning by-laws and subdivision agreements. Through these mechanisms, municipalities may state their intentions concerning energy efficiency, guide planning in that direction, and encourage conservation features to be incorporated into the development.

The objective is to outline for municipalities the important energy conserving site design features to be included in official plans, zoning by-laws and subdivision agreements, and to illustrate these points with examples.

Glossary of terms



Active solar heating system:

energy from the sun which is utilized using technical apparatus and conversion processes.

Altitude and Azimuth (Solar):

two angles used to specify the sun's height above the horizon and bearing at any given time.

Ambient temperature:

temperature in the surrounding environment, such as the temperature around a house.

Deciduous:

type of vegetation which sheds its leaves during the cold months of the year.

Evergreen:

type of vegetation which retains its leaves throughout the year.

Infiltration:

the heat losses associated with outside air entering a building through cracks around windows and doors or in walls, roofs and floors.

Net heat load:

the difference between the heat loss of a dwelling (which is a result of infiltration and transmission losses) and the solar radiation gain through windows and gains from internal heat.

Orientation:

the location of the wall of a dwelling with the greatest amount of window area in relation to the points of the compass.

Passive solar heating system:

energy from the sun which is utilized without using technical apparatus and conversion processes.

Solar access:

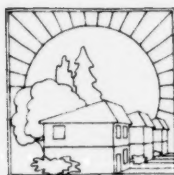
allowing sunlight to penetrate within a building, while the effects of potential obstructions, such as shadows cast by buildings and trees, are eliminated by the proper siting of these elements.

Transmission:

heat transmitted through all components of a building's envelope because of:

- Temperature difference between the inside and outside of a building
- Solar radiation, which raises building surface temperatures above surrounding temperatures
- Wind speed, which when it increases, can cause a more rapid rate of heat transfer – especially through window glass.

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